COGNITION

A Three-Lesson Unit Plan for High School Psychology Teachers

JANUARY 2021

Codey Fickes, MEd, Palmyra Area High School, Pennsylvania
Dana Melone, MAT, Kennedy High School, Iowa
Cedar Riener, PhD, Randolph-Macon College

Developed and Produced by the
Teachers of Psychology in Secondary Schools (TOPSS)
of the American Psychological Association

AMERICAN PSYCHOLOGICAL ASSOCIATION
TOPSS
TEACHERS OF PSYCHOLOGY IN SECONDARY SCHOOLS

AMERICAN PSYCHOLOGICAL ASSOCIATION

SHOUT
SHARE
IT

COGNITION: A Three-Lesson Unit Plan for High School Psychology Teachers

Developed and Produced by the Teachers of Psychology in Secondary Schools (TOPSS) of the American Psychological Association, January 2021

This unit is aligned to the following content and performance standards of the *National Standards for High School Psychology Curricula* (APA, 2011):

Domain	Standard Area	Content and Performance Standards	Supporting Documents and Activities
Cognition	Thinking	**Content Standard 1** Basic elements comprising thought Students are able to (performance standards): 1.1 Define cognitive processes involved in understanding information. 1.2 Define processes involved in problem solving and decision making.	**Lesson One Content Outline** Activity 1: Name that Concept Critical Thinking Exercise 1.1 Is a Hotdog a Sandwich? Critical Thinking Exercise 1.2 "Like a Girl" Commercial Analysis **Lesson Two Content Outline** Activity 2.1: Tower of Hanoi and Chess Activity 2.2: Video Games and Problem Solving Activity 2.3: Compound Remote Associates Problems Activity 2.4: Divergent Thinking with the Alternative Uses Test Critical Thinking Exercise 2.1: Talk Through an Everyday Problem Critical Thinking Exercise 2.2: Problems and Riddles Critical Thinking Exercise 2.3: Reflecting on Incubation and Expertise **Lesson Three Content Outline** Activity 3.2: Guess my Pattern Activity 3.3: I am a Good Person, Aren't I?
Cognition	Thinking	**Content Standard 2** Obstacles related to thought Students are able to (performance standards): 2.1 Describe obstacles to problem solving. 2.2 Describe obstacles to decision making. 2.3 Describe obstacles to making good judgments.	**Lesson Two Content Outline** **Lesson Three Content Outline** Activity 3.1: Availability Heuristic in Action Critical Thinking Exercise 3.1: Cognitive Bias at School *Many of the activities listed under Content Standard 1 also align to this content standard since many of the activities also cover obstacles to problem solving*

Proposed number of days/hours for lesson:
Number of total teaching hours: ~8 hours*

- 10 days in 50-minute classes = 8 hours (one semester class: 5 days = 4 hours)
- 5 days in 90-minute classes = 8 hours (one semester class: 3 days = 4 hours)

*See Introduction

This project was supported by a grant from the American Psychological Foundation David and Carol Myers Fund to Support Teachers of Psychology in Secondary Schools.

COPYRIGHT © 2021
AMERICAN PSYCHOLOGICAL ASSOCIATION.

CONTENTS

Introduction 1

Content Outline 2

Activities and Critical Thinking Exercises 7

Resources 33

PROCEDURAL TIMELINE

Lesson One Cognitive Processes Involved in Understanding Information

Critical Thinking Exercise 1.1: Is a Hotdog a Sandwich?

Activity 1: Name That Concept

Critical Thinking Exercise 1.2: "Like a Girl" Commercial Analysis

Lesson Two Problem Solving

Activity 2.1: Tower of Hanoi and Chess

Activity 2.2: Video Games and Problem Solving

Critical Thinking Exercise 2.1: Talk Through an Everyday Problem

Critical Thinking Exercise 2.2: Problems and Riddles

Activity 2.3: Compound Remote Associates Problems

Activity 2.4: Divergent Thinking with the Alternative Uses Task

Critical Thinking Exercise 2.3: Reflecting on Incubation and Expertise

Lesson Three Judgement and Decision Making

Activity 3.1: Availability Heuristic in Action

Activity 3.2: Guess My Pattern

Activity 3.3: I am a Good Person, Aren't I?

Critical Thinking Exercise 3.1: Cognitive Bias at School

Introduction

This lesson plan is designed to teach a broad range of concepts related to cognition and thinking in a variety of psychology classroom contexts. The various content outlines, activities, and critical thinking exercises were written with the purpose of allowing individual teachers the freedom to pick and choose the activities that fit the needs of their classroom and the diverse learners within it.

The authors thank Teceta Thomas Tormala, PhD, of Palo Alto University and Melanie Wilcox, PhD, of Augusta University for their reviews of this lesson plan.

LESSON ONE

Cognitive Processes Involved in Understanding Information

A concept, to a psychologist, is a mental group of similar things: rows of mental "filing cabinets" that organize everything that we experience in our daily lives. Many other terms and important ideas in psychology revolve around the idea of a concept, because they are the building blocks of thinking and cognition. In this lesson, you will find activities to help students make the abstract idea of a concept more concrete, and an activity that makes students think critically about an important concept they all have in their mind.

DEFINITION OF KEY TERMS

Cognition: Processes of thought such as attending, knowing, remembering, and making decisions

Concept: A mental representation of objects and categories

Formal Concept: A concept with characteristics defined by clear rules

Natural Concept: A concept without clearly defined characteristics

Prototype: A mental representation of the "best example" of a concept

Exemplar: Any item or object that is an example of a given concept

CONTENT OUTLINE

Critical Thinking Exercise 1.1: Is a Hotdog a Sandwich? can be completed to open the lesson.

Cognition: Mental processes associated with thinking, knowing, remembering, and communicating. Cognition is based on the use of concepts. We filter new information through the lens of concepts, and remember information based on concepts.

- Act as mental "filing cabinets" where ideas are stored
- Concepts can be objects, emotions, people
  - Concepts of "chair," "anger," and "mom"

2 Types of Concepts:

- Formal Concepts have clearly defined characteristics and agreed upon rules governing what is included in that concept
  - Examples: triangles, elements in the periodic table, animals
- Natural Concepts do not have clearly defined characteristics nor agreed upon rules of what is included in the concept
  - Examples: Chair, mom, anger

Activity 1: Name That Concept can be completed at this point.

Both formal and natural concepts have prototypes and exemplars.

- Prototype: A mental image or "best example" of a concept. Has all of the most typical features of an item within an overarching concept.
  - Example: Golden Retriever for the concept of "dog" or bald eagle for the concept of "bird"
  - Helpful for cognition: helps us sort items into categories by quickly matching new information up with prototype
    - › Seeing a new exotic type of bird at the zoo and quickly matching it up with the prototype of bald eagle, recognizing it fits the concept, and quickly calling the new animal a bird.
  - Harmful for cognition: Can lead to discrimination if new information does not match up with prototype.
    - › Middle Eastern men more likely to be characterized as terrorists than white men
- Exemplar: Any example of an item within an overarching concept.
  - Robins, blue jays, penguins, ostriches, bald eagle for the concept of "bird"
  - Chihuahua, golden retriever, wolf, St. Bernard for the concept of "dog"

Critical Thinking Exercise 1.2: Like a Girl can be completed at the end of this lesson.

LESSON TWO

Problem Solving

What's your problem? For cognitive psychologists, a problem is simply when we have a goal, and that goal is not yet accomplished. This applies to everything from "I am hungry and there is no food currently in my mouth!" to "My phone screen is broken and I can't see my texts" to "I need to figure out a way to go to school, socialize with friends, and have fun without spreading coronavirus." Cognitive psychologists have studied the mental process of problem solving by investigating how people define problems and how we decide on an approach to solve a problem. Psychologists have also identified common obstacles to effective problem solving and how we can be better problem solvers.

DEFINITION OF KEY TERMS

Problem: A situation in which a person has a goal that is not yet accomplished

Problem space: All possible configurations of steps towards solving a problem

Algorithm: A process or set of steps to solve a problem

Hill-climbing: A type of problem-solving algorithm in which the problem solver takes small steps, evaluating each step whether it brings them closer to the solution

Working backward: A problem-solving algorithm which goes from the solution and takes steps backwards to arrive at the steps toward a solution

Means-end analysis: Solving a problem by a combination of forward- and backward-looking strategies

Convergent Thinking: Type of thinking in which the number of possible solutions is narrowed down to the single best solution.

Divergent Thinking: Type of thinking in which the number of possible solutions is expanded to include multiple feasible solutions.

Insight problems: Problems in which the problem solver comes to the solution all at once, not gradually

Analogical problem solving: Solving a problem by using an analogy to a similar problem for which a solution is known

Incubation: When a problem solver sets aside an unsolved problem and thinks about something else

Fixation: The inability to see a problem from a new perspective

Mental Set: A tendency to approach a problem in a way that has worked in the past

CONTENT OUTLINE

Problem Solving

- What is a problem?
- Problem space—Go over a few problems and problem spaces
    - Examples: Chess and checkers/ board games—all possible moves and games

Activity 2.1: Tower of Hanoi can be completed at this point

- Algorithm—What is the recipe or formula for solving problems?

Different types of problem-solving processes

- Hill climbing—taking small steps—works well for lots of problems (i.e. hills) but not for all, what if you hit a dead end?
    - Example: Climbing a hill, digging a hole, eating your broccoli one bite at a time

Activity 2.2: Video Games and Problem Solving can be completed at this point

- Working backwards—Good for some problems with a clear pathway
    - Example: What do you need to do to get a high school diploma? Take x classes, pass, with y grades. How do you pass with y grades? Do z assignments and tests? How do you do z tests? Study ….
    - Activity: Your school wants to implement a new schedule. Working backwards, what are the steps needed to change to the new schedule for the next school year?
- Means-end analysis—Reduce differences between goal and current state, reduce largest differences first. Works well with subgoals
    - Example: Make a peanut butter and jelly sandwich

Critical Thinking Exercise 2.1: Talk through an Everyday Problem can be completed at this point

- Analogical problem solving—What if there is a similar problem?
    - Example: Sometimes if you have solved a similar problem, you can apply the same problem-solving approach to a new, but similar problem. Let's say the problem is "study for a test in a new class." If you have applied a problem-solving approach like "re-read the textbook, make a quizlet, then quiz each other with a friend," you could apply that same approach to a new problem (a new test in a new class)

Critical Thinking Exercise 2.2: Problems and Riddles can be completed at this point

Obstacles to effective problem solving

- Mental set—A tendency to approach a problem in a way that has worked in the past
- Fixation—We can get stuck on one way of looking at a problem

Activity 2.3: Compound Remote Associates Problems can be completed at this point

Activity 2.4: Divergent Thinking with the Alternative Uses Task can be completed at this point

Tools, skills and habits for effective problem solving

- Incubation—Sometimes setting a problem aside for a time helps
- Expertise—Having extensive background knowledge can help

Critical Thinking Exercise 2.3: Reflecting on Incubation and Expertise can be completed at this point

LESSON THREE

Judgement and Decision Making

Judgement and decision making are an important part of Cognition. The way we choose to solve a problem and the cognitive biases that occur when problem solving are all a part of our previous experiences. This lesson will introduce the main strategies humans use to solve problems as well as the way that our previous experiences can bias our judgement and decision making.

DEFINITION OF KEY TERMS

Confirmation Bias: A tendency to search for information that supports our pre-existing beliefs while ignoring information that contradicts those beliefs

Representative Heuristic: We tend to estimate the likelihood of an event or create a judgment based on how closely they match a prototype or stereotype

Availability Heuristic: We tend to estimate the likelihood of an event based on how available a similar circumstance is in our memory. Events that come easily to mind can cause us to believe they occur more often.

Overconfidence: The tendency to overestimate how accurate our beliefs and judgements are. We tend to be more confident than correct.

Belief Perseverance: We tend to cling to our initial belief even when given evidence to the contrary

Cognitive Dissonance: When our actions do not match our beliefs, we tend to create an excuse to relieve our feelings of discomfort

Framing: The way an issue is posed or worded can change our judgements or decisions

Other Key Terms to Consider: Fundamental attribution error, self-serving bias, ingroup bias, outgroup bias, groupthink, halo effect, false consensus effect, just world phenomenon, victim blaming, Barnum Effect, hindsight bias, social trap, herd behavior, learned helplessness, mental set, fixation

CONTENT OUTLINE

Problem Solving Obstacles

- Confirmation Bias—Our tendency to search for information that supports our beliefs while ignoring information that does not
  - Example: a student believes that their teacher is nicer to girls than to boys. That student is more likely to notice and remember instances of that teacher being nice to girls.
- Availability Heuristic versus Representative Heuristic—The representative heuristic refers to our tendency to use our prototypes to judge the likelihood of an event while the availability heuristic refers to our tendency to believe an event occurs more often if instances of it come readily to mind
  - Example: The representative heuristic can be demonstrated by asking people what the likely job is of someone who is 6'4," can do 100 pushups, and drives a pickup truck (updated example based on Tversky and Kahenman, 1983). Are they more likely to be a nurse or a coal miner? Stereotypes based on these characteristics lead us to ignore that there are far more nurses (over 3 million) than coal miners (~50,000), while the availability heuristic can be shown through statistics of likely events such as car crashes and plane crashes.

Activity 3.1 Availability Heuristic in Action can be completed at this point

- Overconfidence—We tend to be more confident than correct. We believe our own beliefs and judgements are accurate.

Activity 3.2 Guess my Pattern can be completed at this point

- Belief Perseverance—We tend to cling to our initial belief even when given evidence to the contrary
- Cognitive Dissonance—When we have a belief but act in a way that does not match that belief it produces feelings of discomfort. This can cause us to rationalize that action.
  - Example: I believe turning in my homework late is wrong but I forgot to do an assignment and it is now late. I may tell myself or others that it was just that one time and I have never forgotten before.

Activity 3.3 I am a Good Person, Aren't I? can be completed at this point

- Framing—The way an issue is worded can affect the way we make judgments about that situation

Critical Thinking Exercise 3.1 Cognitive Bias at School can be completed at this point

Back to Content Outline

CRITICAL THINKING EXERCISE 1.1
Is a Hotdog a Sandwich?

Concept

This activity can be used to open up this lesson, and hinges on a popular social media debate that students will be familiar with. It gets students thinking about a concept (sandwich) and how concepts guide our thinking (what is a hot dog?).

Materials

This activity can be done with no materials, a whiteboard and markers, or the teacher can use a website such as polleverywhere.com to poll students.

Instructions

- Ask students to consider if a hotdog should be classified as a sandwich and to defend their answer with reasoning.
- Have students think-pair-share about their answers.
- Hold a class discussion and keep track of students' reasons that a hotdog is/is not a sandwich on a whiteboard/projector.
- Explicitly connect this activity to the lesson topic of cognition: Our brains undergo this same process hundreds of times each day, and it allows us to think, remember, understand, and communicate.

Back to Content Outline

ACTIVITY 1
Name That Concept

Concept
This activity will help students to develop a more concrete understanding of their own schemas and their role in cognition. It can be completed prior to introduction of the material of this lesson to stimulate interest, or it can be completed after students have already acquired the information.

Materials
Name that Concept Worksheet

Instructions
This activity takes 5-10 minutes to complete.

- Have students start on page 1 of the Name that Concept worksheet. Ask students to write the concept or category that the listed word belongs to. Teachers may model the first word of "penguin" and give students the concept of "bird."
- Allow students to struggle through page 1 and inform them that they should stop on page 1 and not move onto page 2.
- When students have finished page 1 or are unable to finish, inform them to move onto page 2. Students will begin working and immediately feel relief that the second page is much easier and more familiar than page 1.
- After students complete page 2, ask them why page 2 was easier to complete.
    - Students will note that they have familiarity with concepts on page 2 so they were easier to recognize and name the category. Relate this to the role of concepts in guiding thinking, understanding, and reasoning.

NAME THAT CONCEPT ANSWERS

Page 1 Question	Page 2 Question	Concept for Both Questions
Penguin	Canary	Bird
Scion	Toyota Camry	Car
Eggplant	Carrot	Vegetable
Mauve	Red	Color
Oboe	Piano	Musical Instrument
South Dakota	Maryland	US State
Tonga	Mexico	Country
Nephritis	Asthma	Illness/Disease
Bookcase	Table	Furniture
Sea Hose	Goldfish	Fish

This activity was adapted by Dr. Stacey-Ann Baugh, Associate Professor of Psychology at Trinity Washington University, from:

Goodwin, K., Swinkels, A., & Brown, B. (2002). Instructor's resource manual to accompany Psychology (7th ed., Wade & Tavris). *Upper Saddle River, NJ: Prentice Hall, Inc.*

Name That Concept Worksheet

Penguin _____

Scion _____

Eggplant _____

Mauve _____

Oboe _____

South Dakota _____

Tonga _____

Nephritis _____

Bookcase _____

Sea Hose _____

Name That Concept Worksheet

Canary _____

Toyota Camry _____

Carrot _____

Red _____

Piano _____

Maryland _____

Mexico _____

Asthma _____

Table _____

Goldfish _____

Back to Content Outline

CRITICAL THINKING EXERCISE 1.2
"Like a Girl" Commercial Analysis

Concept

Concepts not only help us to organize information in our brains, but concepts also influence our thoughts and behaviors. This video shows how the concept of a "girl" influences both male and female perceptions of the capabilities and behaviors of a girl.

Materials

- "Like a Girl" video: **https://www.youtube.com/watch?v=XjJQBjWYDTs**
- Optional worksheet (next page)

Instructions

- Tell students that concepts not only exist in the mind, they also inform thoughts and overt behaviors.
- Show students the "Like a Girl" video
- Afterwards, use the discussion questions below as a guide to debriefing the video.

Optional

Have students define the term "concept" in their own words without looking at their notes. Then, have them think-pair-share 5 words or phrases to describe doing something "Like a Girl."

Discussion Questions

- How does this video relate to the idea of a "concept"?
- Is a girl a formal concept or a natural concept? (*There may be interesting debate about this question*)
- What do you think influences our concept of a girl?
- Can we change our concepts? How?
- How might our concepts lead to discrimination? (*Can relate to representativeness heuristic later — our concepts, especially our prototypes can cloud our judgements and decisions*)

"Like a Girl" Worksheet

BEFORE VIEWING

1. Brain Dump: Write down everything you know about the term "concept."

2. What does it mean to you to do something Like a Girl?

AFTER VIEWING

3. How does this video relate to the idea of a concept?

4. Is a girl a formal or natural concept? Why do you believe that?

5. What influences our concept of what it means to be a girl?

6. Can we change our concepts? How?

7. How might our concepts lead to prejudice and/or discrimination?

Back to Content Outline

ACTIVITY 2.1
Tower of Hanoi and Chess

Concept
Explore several simple games and what problem spaces look like with a visual aid.

Materials
Materials are these online games and visualizations

- Tower of Hanoi game: **https://www.mathsisfun.com/games/towerofhanoi.html**
- Chess visualization: **http://www.bewitched.com/chess/**

Time
About 10-15 minutes, but can be longer if students have more appetite for playing Tower of Hanoi

Instructions

- Show students the Tower of Hanoi game and let them play for about 5 minutes, either in small groups, breakout rooms, or on their own. Note how to form the problem space of this game's every possible move and state of the game. You could draw this on the board for the three-disk version, but it gets much more complicated with more disks.
- Then show the chess visualization. This is a computer chess game, but it shows the computer "thinking" by showing the different moves it is considering. It is a compelling visualization of the problem space of a chess game.
- Later in the lesson on problem solving, it is good to return to these examples of games to illustrate other concepts, such as hill climbing, mental set, and expertise

Back to Content Outline

ACTIVITY 2.2
Video Games and Problem Solving

Concept
Help students review what a hill climbing algorithm looks like in the world of familiar video games.

Materials
No materials needed, but several simple online browser-based games might be a fun class activity:

- Frogger: **https://froggerclassic.appspot.com/**
- Slither.io: **http://slither.io/**
- 8 tile puzzle: **https://murhafsousli.github.io/8puzzle/#/**
- Geoguessr: **https://www.geoguessr.com/** (free account needed)

Time
This could be a 10-15 minute discussion with students based on just their previous video game experience. However, students could also play the games in class on a browser, or at home on their own for as long as the instructor would like.

Instructions

- Tell students to think of their favorite video games. Try to describe the video games using "problem spaces" and algorithms that can be used.
- For which elements of the games' "problems" or tasks would a hill-climbing approach (or algorithm) work best?
    - There are some tasks in video games which are simple accumulation or movement in one direction (e.g. in Slither.io the goal is to simply grow your glowing worm by eating glowing dots, in Frogger the goal is to jump across the road, then jump across the river). Many games such as Minecraft or Animal Crossing have relatively little strategy and much more building or steady chipping away at a problem (those both fall under hill climbing algorithms)
- When does hill climbing fail?
    - There are many games and tasks for which hill climbing is not an effective strategy, such as games where more complicated strategy is necessary. Ask students which these would be. The 8 tile puzzle game (or a Rubik's cube) would be a game where a simple hill climbing algorithm might not work well (you can't just make each number get closer to its goal, sometimes you have to make a number go farther from its goal or make the puzzle more jumbled before you solve it). Similar with a game such as Geoguessr — there is no simple accumulation, or gradual steps, or collecting that will lead to a right answer.

Back to Content Outline

CRITICAL THINKING EXERCISE 2.1
Talk Through an Everyday Problem

Concept
Help students review basic concepts in defining what a problem is and processes for solving problems. This activity can help students realize how many steps are involved in solving problems.

Materials
No materials needed

Time
This activity takes 5-10 minutes to complete.

Instructions

- Tell students to first think of a common problem that they have in terms of an unrealized goal
  - Problem: I'm hungry — Unrealized goal: I am not currently eating
  - Problem: My dog is whining — Unrealized goal: Happy dog
  - Problem: My homework is not done — Unrealized goal: Homework finished
- Now ask them to think of the problem spaces for those problems
  - Look for food (could look everywhere in house, could look in places in kitchen), then food could be unwrapped, sliced, baked, cooked, chilled. Then food could be put in a container (plate? cup? bowl?)
  - Dog whining — Problem space — Is dog hungry? Wants to go outside? Wants to be petted? Wants to eat your hot dog? Wants to chew that shoe?
- Now apply methods of problem solving
  - Hill climbing — Can you just get closer to the solution step by step?
  - Working backwards — Can you start at the end and work backwards?
  - Means-end — Combination of working forward and backwards, includes subgoals (*Subgoals of a meal - protein, carb, fruit/vegetable elements?*)

Back to Content Outline

CRITICAL THINKING EXERCISE 2.2
Problems and Riddles

Concept
Key concepts in this activity are how some problems such as these riddles are not easily solved with hill climbing or working backwards, and instead require some sort of shift of thinking, a change of mental set, to solve. Once that change happens, the answer to the riddle is clear and apparent. These problems are often called "insight problems" since they are not solved by gradual progress, but by a moment of insight.

Materials
Problem solving handout

Time
This activity takes as long as you like. You can select any number of the riddles and give students as much time as you have for completing them.

Instructions
- These can be completed on their own as homework, or in class as a class activity. Often they work well in which students try on their own for a certain amount of time, then get together as a group and try to solve them together.
- Discuss with students their process of trying to solve the riddles using terms such as incubation and fixation. For the solutions, did they require them to break out of their mental set?

Problem Solving Riddles Handout

From Batchelder & Alexander (2012)

1. There are ten bags, each containing ten gold coins, all of which look identical. In nine of the bags each coin is 16-ounces, but in one of the bags the coins are actually 17-ounces each. How is it possible, in a single weighing on an accurate weighing scale, to determine which bag contains the 17-ounce coins

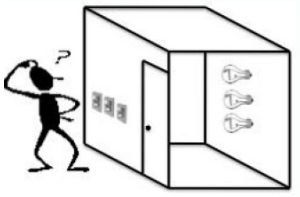
2. Marsha and Marjorie were born on the same day of the same month of the same year to the same mother and the same father yet they are not twins. How is that possible?

3. You have ten volumes of an encyclopedia numbered 1, . . . ,10 and shelved in a bookcase in sequence in the ordinary way. Each volume has 100 pages, and to simplify suppose the front cover of each volume is page 1 and numbering is consecutive through page 100, which is the back cover. You go to sleep and in the middle of the night a bookworm crawls onto the bookcase. It eats through the first page of the first volume and eats continuously onwards, stopping after eating the last page of the tenth volume. How many pieces of paper did the bookworm eat through?

4. Look at the nine dots in Figure 3. Your job is to take a pencil and connect them using only three straight lines. Retracing a line is not allowed and removing your pencil from the paper as you draw is not allowed. Note the usual nine-dot problem requires you to do it with four lines; you may want to try that stipulation as well.

FIGURE 3.
The setup for the Nine-Dot Problem.

5. You are standing outside a light-tight, well-insulated closet with one door, which is closed. The closet contains three light sockets each containing a working light bulb. Outside the closet, there are three on/off light switches, each of which controls a different one of the sockets in the closet. All switches are off. Your task is to identify which switch operates which light bulb. You can turn the switches off and on and leave them in any position, but once you open the closet door you cannot change the setting of any switch. Your task is to figure out which switch controls which light bulb while you are only allowed to open the door once.



The setup of the Light Bulb Problem.

6. You have two quart-size beakers labeled A and B. Beaker A has a pint of coffee in it and beaker B has a pint of cream in it. First you take a tablespoon of coffee from A and pour it in B. After mixing the contents of B thoroughly you take a tablespoon of the mixture in B and pour it back into A, again mixing thoroughly. After the two transfers, which beaker, if either, has a less diluted (more pure) content of its original substance - coffee in A or cream in B? (Forget any issues of chemistry such as miscibility).

7. There are two large jars, A and B. Jar A is filled with a large number of blue beads, and Jar B is filled with the same number of red beads. Five beads from Jar A are scooped out and transferred to Jar B. Someone then puts a hand in Jar B and randomly grabs five beads from it and places them in Jar A. Under what conditions after the second transfer would there be the same number of red beads in Jar A as there are blue beads in Jar B.

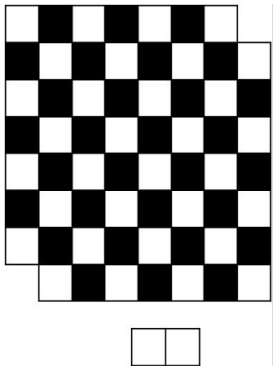
8. Rearrange the letters to make words (Anagrams task):

   COSYHOGPLY _____

   TREMSEES _____

   VANGIGSTHINK _____

   MTIEULNHC _____



9. To the right is a checkerboard in which two squares have been removed, leaving 62 squares instead of 64. If you had 31 dominos, each of which could cover two squares, could you cover the remaining 62 squares? If so, show how it can be done. If not, prove that it cannot be done.

10. A landscape gardener is given instructions to plant four special trees so that each one is exactly the same distance from each of the others. How is this possible?

11. What is the sum of the numbers from 1 to 100? (there is a quick and easy way to do this)

12. You are a doctor. A patient comes to you with a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed, the patient will die. There is a kind of ray which can be used to destroy the tumor. If the rays reach the tumor all at once at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays without destroying the healthy tissue?

13. A woman who lived in a small town married 20 different men in that same town. All of them are still living, and she never divorced any of them. Yet she broke no laws. How could she do this?

REFERENCE

Batchelder, W.H. & Alexander, G.E. (2012) Insight problem solving: A critical examination of the possibility of formal theory. *Journal of Problem Solving. 5*(1). http://dx.doi.org/10.7771/1932-6246.1143

Solutions to Problem Solving Riddles

From Batchelder & Alexander (2012)

1. Solution: Take 1 from the 1st bag, 2 from the 2nd, 3 from the 3rd, etc. Then weigh all those coins. If all the bags weigh 16 ounces you will have 55 ounces (10+9+8+7+6+5+4+3+2+1). Any amount in excess of the 55 ounces will determine which bag contains the 17 ounces (two ounces over = bag 2, if it is 7 ounces over = bag 7, etc).

2. Solution: They're triplets.

3. Solution: The correct answer is 402 pieces of paper. In books, pieces of paper are numbered on both sides. Furthermore, examining the way the books are stacked in Figure 2, the worm only eats one piece of paper in the first and tenth volumes; where as it eats 50 pieces of paper in the other eight volumes.

4. Solution: See https://www.youtube.com/watch?v=a-6-2kZZe2w

5. Solution: Light bulbs in sockets get warm when they are on. Turn one switch on and leave it on. Turn another switch on for a few minutes and then turn it off. Enter the closet without touching the third light switch. The first switch controls the light that is on, the second controls the light that is off but warm, and the untouched switch controls the light that is off and not warm.

6. Solution: The solution follows from the logic of the solution to Problem 8 next. Any volume of cream that ends up in the coffee is exactly matched by a displacement equal to the amount of coffee in the cream mixture. Thus both beakers are equally diluted.

7. Solution: Each blue bead that was transferred into the red bead jar matches with a red bead that remains in the blue bead jar. So in all cases, there are as many red beads in the blue jar as there are blue beads in the red jar.

8. Solution to anagrams task:

   COSYHOGPLY _____ *psychology*
   TREMSEES _____ *semester*
   VANGIGSTHINK _____ *thanksgiving*
   MTIEULNHC _____ *lunchtime*

9. Solution: Cannot be done. There are two more white squares than black squares, and no domino can be placed so that it covers two white squares.

10. Solution: Plant three in a triangle, then fourth on a hill (or in a hole) in the middle.

11. Solution: 1+100 = 101, 2+99 = 101 .... 50 pairs of 101 = 5050

12. Solution: Split up the rays so that they meet at the tumor.

13. Solution: She was the priest/pastor/officiant of their weddings.

REFERENCE

Batchelder, W.H. & Alexander, G.E. (2012) Insight problem solving: A critical examination of the possibility of formal theory. *Journal of Problem Solving. 5*(1). http://dx.doi.org/10.7771/1932-6246.1143

Back to Content Outline

ACTIVITY 2.3
Compound Remote Associates Problems

Concept

Compound Remote Associates Problems (CRAP) or the Remote Associates Test (RAT) are common laboratory tasks used in studies of problem solving. They give students a chance to have fun, try to solve problems, and also observe some of the cognitive processes involved as they attempt to solve word problems. They are also used in a common test of creativity.

Materials

- **https://www.remote-associates-test.com/**
- Compound Remote Associates Problems Worksheet

As indicated on the website, these are taken from:

Bowden, E.M., & Jung-Beeman, M. (2003). Normative data for 144 compound remote associate problems. *Behavioral Research Methods, Instrumentation, and Computers, 35*, 634-639.

Mednick, S.A., & Mednick, M.T. (1967). *Examiner's manual: Remote Associates Test*. Boston: Houghton Mifflin

Bowers, K.S., Regehr, G., Balthazard, C.G., & Parker, K. (1990). Intuition in the context of discovery. *Cognitive Psychology, 22*, 72-110.

Gardner (1980). *Exercises for general psychology*. (Minneapolis: Burgess), pp. 115-116

McFarlin and Blascovich (1984) in *Basic and Applied Social Psychology, 5*(3), 223-229

Time

Can take anywhere from 10-20 minutes, depending on how long the students would like to work on them.

Instructions

- Each RAT question presents three cue words that are linked by a fourth word, which is the correct answer.
- Very simple and straightforward instructions, but best to do one or two together as a group. For example, if the three words are cottage, swiss, and cake, the answer is cheese (cottage cheese, swiss cheese, cheesecake).

Compound Remote Associates Problems Worksheet

Each of the three words on the left is associated with a single word. Find that word. The first two examples are given Star — ("falling star" and "star actor" and "stardust") and Glass ("broken glass," "clear as glass" and "eyeglass")

Falling Actor Dust	Star
Broken Clear Eye	Glass
Skunk Kings Boiled	
Widow Bite Monkey	
Bass Complex Sleep	
Coin Quick Spoon	
Gold Stool Tender	
Time Hair Stretch	
Cracker Union Rabbit	
Bald Screech Emblem	
Salt Deep Foam	
Square Cardboard Open	
Water Tobacco Stove	
Ache Hunter Cabbage	
Lick Sprinkle Mines	
Pure Blue Fall	
Snack Line Birthday	
Blade Witted Weary	
Cherry Time Smell	
Notch Flight Spin	
Strap Pocket Time	
Walker Main Sweeper	
Wicked Bustle Slicker	
Chocolate Fortune Tin	
Color Numbers Oil	

Ink Herring Neck	
Measure Desk Scotch	
Strike Same Tennis	
Athletes Web Rabbit	
Board Magic Death	
Lapse Vivid Elephant	
Puss Tart Spoiled	
Rock Times Steel	
Zone Still Noise	
Cloth Sad Out	
Cotton Bathtub Tonic	
Foot Collection Out	
Jump Kill Bliss	
Magic Plush Floor	
Note Dive Chair	
Stalk Trainer King	
Bump Throat Sum	
Shopping Washer Picture	
Blank White Lines	
Stick Light Birthday	
Sore Shoulder Sweat	

Compound Remote Associates Problems Worksheet Solutions

Falling Actor Dust	Star
Broken Clear Eye	Glass
Skunk Kings Boiled	Cabbage
Widow Bite Monkey	Spider
Bass Complex Sleep	Deep
Coin Quick Spoon	Silver
Gold Stool Tender	Bar
Time Hair Stretch	Long
Cracker Union Rabbit	Jack
Bald Screech Emblem	Eagle
Salt Deep Foam	Sea
Square Cardboard Open	Box
Water Tobacco Stove	Pipe
Ache Hunter Cabbage	Head
Lick Sprinkle Mines	Salt
Pure Blue Fall	Water
Snack Line Birthday	Cake
Blade Witted Weary	Dull
Cherry Time Smell	Blossom
Notch Flight Spin	Top
Strap Pocket Time	Watch
Walker Main Sweeper	Street
Wicked Bustle Slicker	City
Chocolate Fortune Tin	Cookie
Color Numbers Oil	Paint

Ink Herring Neck	Red
Measure Desk Scotch	Tape
Strike Same Tennis	Match
Athletes Web Rabbit	Foot
Board Magic Death	Black
Lapse Vivid Elephant	Memory
Puss Tart Spoiled	Sour
Rock Times Steel	Hard
Zone Still Noise	Quiet
Cloth Sad Out	Sack
Cotton Bathtub Tonic	Gin
Foot Collection Out	Stamp
Jump Kill Bliss	Joy
Magic Plush Floor	Carpet
Note Dive Chair	High
Stalk Trainer King	Lion
Bump Throat Sum	Lump
Shopping Washer Picture	Window
Blank White Lines	Paper
Stick Light Birthday	Candle
Sore Shoulder Sweat	Cold

Back to Content Outline

ACTIVITY 2.4
Divergent Thinking with the Alternative Uses Test

Concept

There are many measures of creativity, many of which use divergent thinking as one aspect of creativity. Guilford (1960) created the Alternative Uses Test, and it has been widely used as one measure in a basket of creativity tests.

Materials

- Alternative Uses Test Worksheet
- Timer

Instructions

- This activity can take 5-20 minutes to complete, depending on the class time available.
- Inform students that this is a test of divergent thinking and they should generate as many uses for the object(s) that you say out loud as possible.
- Give students a time constraint: 2-5 minutes per item works best, depending on the class time available.
- Remind students that they should work independently and think of uses beyond the typical use for each item.
- Review the scoring criteria with them prior to beginning the activity. Each use listed is scored in 4 categories, with a minimum of 0 points and a maximum of 6.
- Have students self-score or work with a partner to score their responses based on the scoring criteria.

Materials for this activity were designed by consulting:

Guilford, J. P., Christensen, P. R., Merrifield, P. R., & Wilson, R. C. (1960). *Alternate uses manual.* Menlo Park, CA: Mind Garden, Inc.

ALTERNATIVE USES STIMULUS ITEMS FOR TEACHERS

Paperclip	Brick
Newspaper	Ping-Pong Ball
Cup	Shoe
Knife	Pencil

ALTERNATIVE USES TEST SCORING CRITERIA

Criteria	Description	Number of Points
Fluency	The number of uses written	-1 point for each unique item listed
Originality	How common the use of the object is with respect to the answers of others	• -0 points if >20% of class wrote the same item • -1 point if 10%-20% of class wrote the same item • -2 points if <10% of class wrote the same item
Flexibility	How many different categories the uses cover	-1 point for each unique category (e.g., accessory, toy, cooking utensil, etc.)
Elaboration	Amount of detail given for the use of the object	• -0 points for no elaboration (e.g., a screwdriver) • -1 point for some elaboration (e.g., a screw driver for eyeglasses) • -2 points for detailed elaboration (e.g., a screwdriver to scrape off price tag residue from a purchase)

Guilford Alternative Uses Test Worksheet

Directions

For the items read aloud, write down the name of the item provided, and under it write down as many uses for the object as possible. Try to think "outside the box" as much as possible.

Item 1:	Item 2:

Back to Content Outline

CRITICAL THINKING EXERCISE 2.3
Reflecting on Incubation and Expertise

Concept
How do the concepts of expertise and incubation apply to the previous activities?

Materials
No materials needed

Time
This activity takes 10-15 minutes to complete.

Instructions

- Pick one or two of the previous activities
- Ask students to think about how expertise might apply to that activity
  - How does chess expertise help chess players solve problems? — Have they memorized both how the pieces move, but also typical positions or typical sub-problems in chess?
  - How does video game expertise help video game players? — Are there sub-types of video games that one can be an expert on? Are there similar problems that video game players confront? Are there similar "moves" across video games? Are there similar problems to be solved? (*This can also be a review of analogical problem solving*)
  - How might expertise in everyday problems like cooking or cleaning or driving help those experts solve those problems?
- Ask students about how incubation might apply to these situations.
  - Have they ever put down a problem to sleep on it and woken up with a solution?
  - Did they experience an "a-ha" moment in the RAT problems? Do they think they could solve any more the next day?

Back to Content Outline

ACTIVITY 3.1
Availability Heuristic in Action

Concept

The availability heuristic can cloud our judgements and decisions based on the ease and speed of recalling a similar situation. With this activity, you will most likely be able to induce your students to commit the availability heuristic. Afterwards, you can debrief with them to find out how and why the availability heuristic happens. Data from this activity is based on 2017 data available on the CDC's website below:

Materials

- Leading Causes of Death Ranking Worksheet
- **https://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm**

Instructions

- Students should individually rank the causes of death based on their own thoughts and knowledge. They should not research the answers.
- You may have students share with a partner/group if you would like.
- Review the true answers with students according to the CDC's Leading Causes of Death website.

Debriefing Questions

- Which causes of death did you rank correctly/almost correctly?
- Which causes of death did you rank very incorrectly? (5-7+ away from the actual ranking)
- Why do you think you ranked the ones correctly and incorrectly that you did?
- Did the media (social media, news, etc.) influence your decisions? In what way?

Teacher Answer Key

1. Heart disease: (647,457 deaths)
2. Cancer: (599,108 deaths)
3. Accidents (unintentional injuries): (169,936 deaths)
4. Chronic lower respiratory diseases: (160,201 deaths)
5. Stroke (cerebrovascular diseases): (146,383 deaths)
6. Alzheimer's disease: (121,404 deaths)
7. Diabetes: (83,564 deaths)
8. Influenza and pneumonia: (55,672 deaths)
9. Nephritis, nephrotic syndrome, and nephrosis: (50,633 deaths)
10. Intentional self-harm (suicide): (47,173 deaths)

This activity was adapted by Dr. Stacey-Ann Baugh, Associate Professor of Psychology at Trinity Washington University, from:

Goodwin, K., Swinkels, A., & Brown, B. (2002). Instructor's resource manual to accompany Psychology (7th ed., Wade & Tavris). *Upper Saddle River, NJ: Prentice Hall, Inc.*

Leading Causes of Death in the United States Worksheet

Directions
Below you will find the top 10 leading causes of death in the United States. On the blanks beside each cause of death, order from 1-10 the order of the causes of death based on your knowledge.

_____ Accidents

_____ Alzheimer's Disease

_____ Lower Respiratory Disease

_____ Nephritis

_____ Cancer (all types)

_____ Suicide

_____ Influenza and Pneumonia

_____ Stroke

_____ Diabetes

_____ Heart Disease

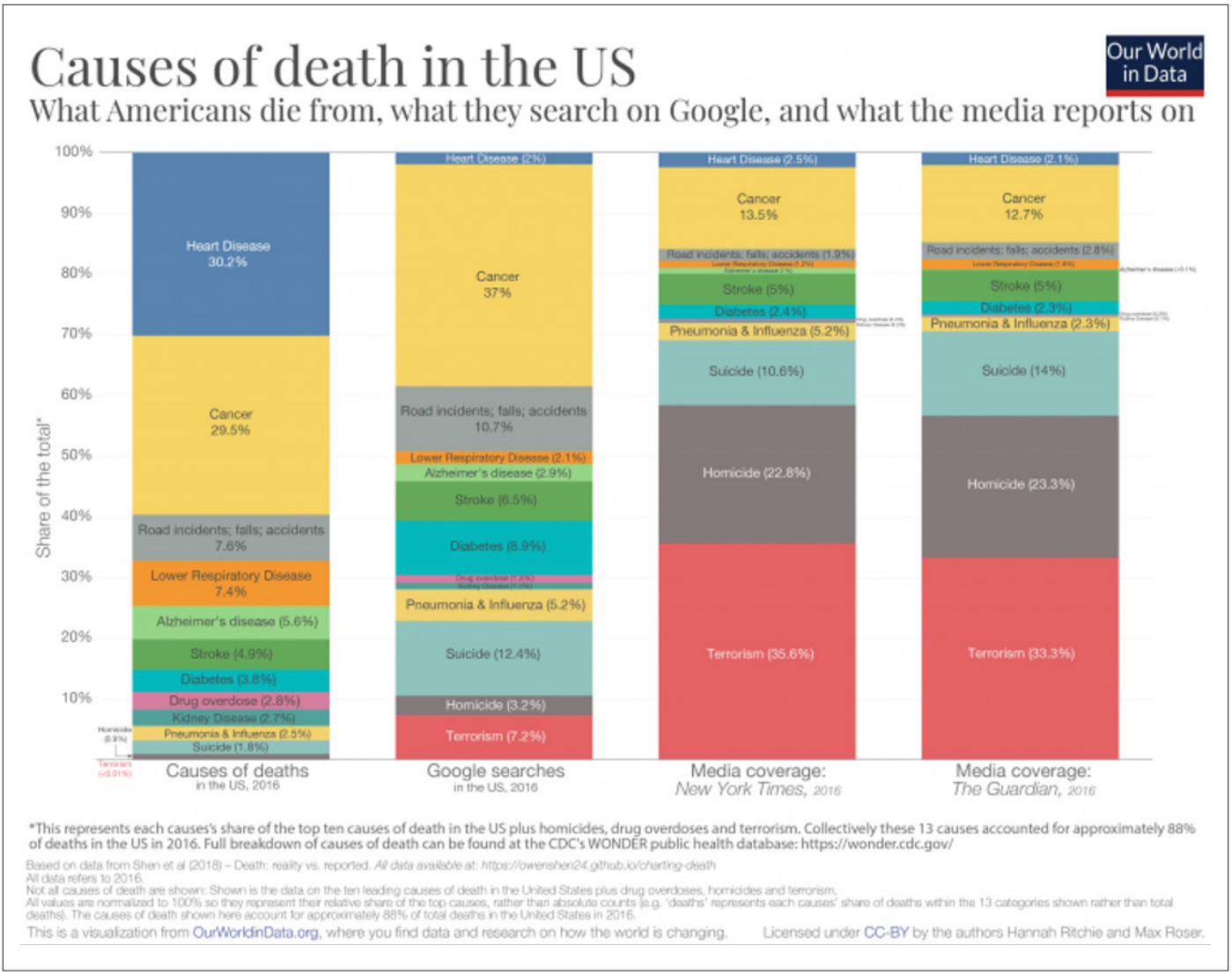
ADDENDUM FOR ACTIVITY 3

Availability Heuristic, Media Coverage, and COVID-19

https://www.considerable.com/health/coronavirus/coronavirus-deaths-vs-leading-causes-death-chart/

- Interactive

The chart below is reprinted with permission from **https://ourworldindata.org/does-the-news-reflect-what-we-die-from**


Causes of death in the US
What Americans die from, what they search on Google, and what the media reports on
Our World in Data
Share of the total*
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
Heart Disease 30.2%
Cancer 29.5%
Road incidents; falls; accidents 7.6%
Lower Respiratory Disease 7.4%
Alzheimer's disease (5.6%)
Stroke (4.9%)
Diabetes (3.8%)
Drug overdose (2.8%)
Kidney Disease (2.7%)
Pneumonia & Influenza (2.5%)
Suicide (1.8%)
Causes of deaths in the US, 2016
Heart Disease (2%)
Cancer 37%
Road incidents; falls; accidents 10.7%
Lower Respiratory Disease (2.1%)
Alzheimer's disease (2.9%)
Stroke (6.5%)
Diabetes (8.9%)
Pneumonia & Influenza (5.2%)
Suicide (12.4%)
Homicide (3.2%)
Terrorism (7.2%)
Google searches in the US, 2016
Heart Disease (2.5%)
Cancer 13.5%
Road incidents; falls; accidents (1.9%)
Stroke (5%)
Diabetes (2.4%)
Pneumonia & Influenza (5.2%)
Suicide (10.6%)
Homicide (22.8%)
Terrorism (35.6%)
Media coverage: New York Times, 2016
Heart Disease (2.1%)
Cancer 12.7%
Road incidents; falls; accidents (2.8%)
Stroke (5%)
Diabetes (2.3%)
Pneumonia & Influenza (2.3%)
Suicide (14%)
Homicide (23.3%)
Terrorism (33.3%)
Media coverage: The Guardian, 2016
*This represents each causes's share of the top ten causes of death in the US plus homicides, drug overdoses and terrorism. Collectively these 13 causes accounted for approximately 88% of deaths in the US in 2016. Full breakdown of causes of death can be found at the CDC's WONDER public health database: https://wonder.cdc.gov/
Based on data from Shen et al (2018) – Death: reality vs. reported. All data available at: https://owenshen24.github.io/charting-death
All data refers to 2016.
Not all causes of death are shown: Shown is the data on the ten leading causes of death in the United States plus drug overdoses, homicides and terrorism.
All values are normalized to 100% so they represent their relative share of the top causes, rather than absolute counts (e.g. "deaths" represents each causes' share of deaths within the 13 categories shown rather than total deaths). The causes of death shown here account for approximately 88% of total deaths in the United States in 2016.
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.
Licensed under CC-BY by the authors Hannah Ritchie and Max Roser.

Back to Content Outline

ACTIVITY 3.2
Guess My Pattern

Concept
This activity can be used before or after students have an understanding of problem-solving obstacles. It specifically addresses the problem-solving obstacles of overconfidence and confirmation bias. It is based on a study by Peter Wason (1960).

Time
This activity takes about 15 minutes

Materials
This activity can be done by providing students with a simple chart and directions similar to the one below:

Number Pattern Example A _____

Number Pattern Example B _____

My Guess for the Description of the Pattern	Percent Confident

Instructions
- Hand out chart
- Tell students you are going to give them an example of a number pattern, but you will not describe the actual pattern
- Tell students that without talking they can guess what they think the pattern is and write down how confident they are that they are correct
- When they have taken their first guess they are to raise their hand
- Teacher walks around the room checking answers. If a student gets it correct flip their paper over, they are done. If a student gets it wrong, they can keep guessing.
- After a few walks around the room where students are not guessing the pattern, give them a secondary example that fits the pattern and continue until ⅓ of the room has figured it out.
- Pattern example: You can tell students your pattern is 2,4,6. You will then be looking for the answer of ascending numbers. Students will likely not guess that so after a few rounds you can give them a secondary pattern example of 10, 20, 30.

Follow Up
Following this activity is a great time to have students identify what cognitive biases they fell victim to while doing this activity.

REFERENCE

Wason, P. C. (1960). On the failure to eliminate hypotheses in a conceptual task. *Quarterly Journal of Experimental Psychology, 12*, 129–140.

Back to Content Outline

ACTIVITY 3.3
I am a Good Person, Aren't I?

Concept
This activity will help students understand the concept of cognitive dissonance as well as other concepts by bringing to the surface some of their own cognitive dissonance. This activity can be used before or after students have an understanding of the cognitive biases. Author's Note: The original source of this activity is unknown.

Materials
No materials needed

Time
This activity takes 5-10 minutes to complete.

Instructions
- Tell students you are going to state a series of opinions. They should stand up if they agree with the statement. Statements should be non-controversial and get almost every student standing.
- Examples of Statements you can use
  - I believe littering contributes to the pollution of our planet.
  - I believe world hunger is a problem.
  - I believe studying by cramming is not an effective method for long term learning.
- Note the number of students standing.
- Now explain to students that you will state three other statements and they should stand if they agree with the statement. These statements should refer to the first set of statements but add in the element of personal responsibility and action.
  - I pick up trash I find as I am walking every time I see it.
  - I help combat hunger on a regular basis (e.g., volunteering at or donating to a food shelter.)
  - I do not cram for my exams. I always study using effective methods.

Follow up
This is a good time to discuss cognitive dissonance and why their actions do not match their beliefs. When students share their answers, it is a good time to note that not all reasons that our actions do not match our beliefs are lies. Excuses can be truths.

Back to Content Outline

CRITICAL THINKING EXERCISE 3.1

Cognitive Bias at School

Dana Melone, MAT
Kennedy High School, Cedar Rapids, Iowa

Concept

The following exercise will get students thinking about the cognitive bias in relation to their everyday life. This particular example used school as the framework but can be adapted for many relevant current events in our world

Materials

The following chart on a worksheet or online platform for students

Time

This activity takes 30-50 minutes depending on how much discussion time you want to give

Instructions

- Give students the following chart.
- Students can work in groups or alone
- Student can work without notes
- Have students use the cognitive biases and obstacles to problem solving to fill out the chart

Cognitive Bias at School Worksheet

	Give an example of this as a problem for students during the school day	How can we help students overcome this	Give an example of this as a problem for teachers during the school day	How can we help teachers overcome this
Framing				
Confirmation Bias				
Fixation				
Functional FIxedness				
Representative Heuristic				
Availability Heuristic				
Overconfidence				
Learned Helplessness				
Belief Perseverance				
Cognitive Dissonance				
Herd Behavior				

American Psychological Association. (2011). *National standards for high school psychology curricula*. Retrieved from https://www.apa.org/education/k12/national-standards

Bensley, D. A., & Lilienfeld, S. O. (2017). Psychological Misconceptions: Recent Scientific Advances and Unresolved Issues. *Current Directions in Psychological Science, 26*(4), 377–382. https://doi.org/10.1177/0963721417699026

Fernandez, E. (n.d.) Visual study guide to cognitive biases. Royal Society of Account Planning. https://www.scribd.com/doc/30548590/Cognitive-Biases-A-Visual-Study-Guide

Dunning, D., Heath, C., & Suls, J. M. (2018). Reflections on self-reflection: Contemplating flawed self-judgments in the clinic, classroom, and office cubicle. *Perspectives on Psychological Science, 13*(2), 185–189. https://doi.org/10.1177/1745691616688975

Gladwell, M. (2005). *Blink: The Power of Thinking Without Thinking*. Little, Brown and Co.

Groopman, J (2007, January 29) What's the trouble? *The New Yorker*.

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.

Lehrer, J (2008, July 28) The eureka hunt: Why do good ideas come to us when they do? *The New Yorker*.

Kolbert, E (2008, February 25) What was I thinking? The latest reasoning about our irrational ways. *The New Yorker*.

McRaney, D. (2011). *You Are Not So Smart*. Penguin Groups.

AMERICAN
PSYCHOLOGICAL
ASSOCIATION

AMERICAN PSYCHOLOGICAL ASSOCIATION

TOPSS

TEACHERS OF PSYCHOLOGY
IN SECONDARY SCHOOLS